DAM SAFETY SECTION
CRITICAL INFRASTRUCTURE DIVISION

Dam Safety Inspection Report

GENERAL INFORMATION

INVENTORY NO.: TX01602

DAM: Lake Dunlap Dam

OWNER: Guadalupe-Blanco River Authority (GBRA)

STREAM: Guadalupe River

BASIN: Guadalupe River Basin

COUNTY: Guadalupe

GENERAL LOCATION: 5 miles southeast of New Braunfels

DAM HEIGHT: 41-ft

SIZE CLASSIFICATION: Intermediate

NORMAL CAPACITY: 5900 ac-ft

MAXIMUM CAPACITY: 14,330 ac-ft

NORMAL WATER LEVEL: 575.2 msl

CURRENT WATER LEVEL: 575.4 msl

PREVIOUS INSPECTION DATE: 5/7/2013

CURRENT INSPECTION DATE: 6/13/2018

INSPECTION BY TCEQ PERSONNEL: Robert Calderon, P.E., Michelle Lu, EIT, and Tim Kunze

PERSONNEL CONTACTED: Charles Hickman, P.E. (GBRA Water Resources Engineer); Jeff McKee (GBRA – Hydro Operations); 3 additional GBRA staff – Thomas Salinas, Michael Pena, and Ashley Freidburg

SUMMARY

Lake Dunlap Dam is an intermediate sized composite dam with an in-channel concrete gravity structure and earthen embankments outside

of the river channel. The dam was inspected by TCEQ Dam Safety staff on June 12, 2018 as part of a routine safety inspection and was found in good overall condition. The minor deficiencies noted during this inspection were maintenance in nature and included grass, small trees, and shrubs growing around the headgate for the diversion canal, through timbers of the service spillway gates, and at the debris chute just before the powerhouse. The seepage layer at the groin of the left downstream side of the service spillway has been identified and is routinely monitored by GBRA staff. Due to the upgrade in the GBRA maintenance program no cracks, potential movement, or open joints in concrete appeared to have developed beyond what was noted in the previous inspection. However, a long-range plan to address areas of scour, hydraulic adequacy, and a finalized Emergency Action Plan (EAP) are required for this dam.

BACKGROUND

TCEQ Dam Safety records indicate that Lake Dunlap Dam (also known as TP-1) and the associated powerhouse were originally constructed in 1928 for the Guadalupe-Blanco River Authority. The permit for continuous use of 1300 cfs of water for hydroelectric power was granted as far back as July 25, 1914. The dam has been inspected by the Texas Dam Safety Program or sub-contractors for the state many times going back as far as 1969, prior to this most recent inspection. Additionally, the GBRA had an underwater inspection performed by Neptune Underwater Services (Oct-2010). It is not known if any recommendations were made along with the underwater inspection. The inspection mostly identified areas of scour at the base of the dam concrete structure.

Over the course of several decades, the fender boards which provide the outer skin to the Huber-Lutz roof weir gates, have been replaced to prolong the lifespan of the gates. The gates which are lowered to pass flood flows, are still often damaged from debris floating down the river during large storm events. Accordingly, the fender boards are routinely assessed and replaced as needed. Additionally, repairs to the gate's tie bars, locking bars, and miscellaneous steel had reportedly been completed in 2012. Other than maintenance (repair to concrete structures, wing walls, powerhouse and generators, and the addition of a spillway along the diversion canal), no additional dam modifications are noted in TCEQ Dam Safety records. Since the last inspection and before this current inspection, the catwalk over the service spillway was closed for cost-saving purposes and portions of the catwalk have been permanently removed.

Deficiencies that have been noted in past inspections included damage (cracks, spalls, broken sections and separation at joints) to the wing-walls at the downstream end of the service spillway structure. The majority of the deficiencies have been noted to the left downstream wing-wall, but some cracking has also been noted along the right wing wall as well. Seepage has been noted periodically behind the left wall and the groin area going back for many inspections. Other deficiencies have included animal burrows in grassy sections of the embankment, as well as erosion around the stilling basin. In October of 1998, the diversion canal to the powerhouse breached which actually relieved pressure on the dam. While the emergency spillway did not engage in that flood, it is believed that it would have if not for the canal breach. Finally, after the 2008 inspection noted several problem areas, GBRA upgraded their maintenance program to address wear issues with all of the concrete structures and slope protection. Since that inspection, cracks, open joints, and areas of potential concrete movement have been notably addressed and none of the previously identified problem areas have become worse. The dam was last rated in good overall condition.

PRE-INSPECTION MEETING

Mr. Charles Hickman (GBRA - Water Resources Engineer) was contacted approximately 2 weeks prior to the inspection and in a brief phone call was informed of the nature of the safety inspection. Mr. Hickman was unavailable for the scheduled inspections, but Jeff McKee (Hydro Operations Manager), as well as other GBRA staff, were present throughout the inspection and discussed the general maintenance level and recent history of the dam. Mr. McKee and staff were appraised of the overall dam condition at the end of the inspection. Mr. McKee also notified the TCEQ inspectors that GBRA was considering completely removing the current Huber and Lutz roof-weir spill gates from the service spillway and replacing them with hydraulic crest gates once funds became available and plans were approved.

INSPECTION FINDINGS

Figure 1 is a location map of the Lake Dunlap Dam relative to the City of New Braunfels and the major roadways in the area. Figure 2 is an aerial photo of the dam with elevation contours. Figure 3 is a sketch of the dam indicating photo locations. Lastly, for purposes of clarification, any “Left” and “Right” designations in this report are from the viewpoint of looking downstream of the dam. During this

inspection, the water surface was approximately 0.2-ft above the service spillway (normal pool level).

CREST

- The dam is approximately 1800-ft long with a varying crest width (from approximately 8 to 10-ft wide). One short section (very end) of the crest on the south side of the river is approximately 3-ft wide.
- The crest consists mostly of a short good grass surface with some areas where the grass was longer. The section south of the river has a slight crown while the section north of the river is relatively flat. The crest was found in good overall condition (See Photos 1-4).
- The crest was mostly level with no significant dips or low spots noted. However, 2011 LiDAR data noted in the previous inspection provides evidence that some low areas exist relative to the top of dam (the effective top of dam may be over 1.5-ft lower than TCEQ records). However, it is unknown if the LiDAR data accounts for the parapet wall in this location.
- Burrows from Armadillo activity which were noted in the last inspection were not observed during this inspection.

UPSTREAM SLOPE

- The upstream slope is primarily protected by concrete apron and retaining/parapet walls. The overall slope was estimated at approximately 3 horizontal to 1 vertical (3H:1V) and was found in good overall condition (See Photos 5-7).
- The concrete parapet wall along the section south of the river was in good condition but had an exposed rebar section.
- Some spalling and cracks (with most of them sealed) were noted in the concrete slope protection but overall the concrete appeared to be in the same condition as noted in the last inspection.
- A small displacement at the joint of two sections of the parapet wall and slope noted in the previous inspection (near left end) was not observed during this inspection.
- Also, along the wall section (south of the river immediately next to spillway), a large crack noted in the previous inspection was not observed.

DOWNSTREAM SLOPE

- The downstream slope had a good grass surface with a concrete apron section closest to the north side of the service spillway. The overall slope was estimated at approximately 3 horizontal to 1 vertical (3H:1V) and was found in fair overall condition (See Photos 8-14).
- The concrete apron section along the downstream slope had all open joints and cracks sealed and patched. No gaps or separations in the concrete were noted. A soil-cement section located above the concrete apron appeared to be stable with no breaks or buckling noted. However, there was a little grass growing through the soil-cement section.
- The groin area at the toe of the downstream slope nearest the north side of the spillway had a consistent seep. GBRA staff graded the topsoil layer and placed rock rubble and a temporary weir that was previously capable of measuring the flow. However, the seepage was noted to be passing beneath the weir and was not being measured.
- GBRA staff explained that they were in consultation with their engineer to come up with a long-term solution for this seepage layer. Seepage had been noted in this location in previous inspections.

SERVICE SPILLWAY

- The service spillway consists of a concrete structure with three 85-ft wide by 12-ft high Huber and Lutz roof-weir (bear trap) service spillway gates. The gates are a fabricated steel skeleton with timber planks along the surface and raised and lowered based on significant rainfall events. The spillway was rated in good overall condition (See Photos 15-20).
- An operational assessment of the spillway gates was not performed, and the interior gallery of the gates was not inspected due to safety considerations. However, based on visual inspection of the exterior of the gates and the reported operational maintenance history, the gates appeared to be in good operating condition, and GBRA staff did not indicate any critical concerns with gate procedures.
- Unwanted vegetation was noted (small shrub) growing through some of the boards on the gates.
- The previous inspection noted several cracks and open joints in several areas of the concrete structure that had been sealed or

patched. All of these areas appeared to be in the same condition or better than noted in that previous inspection.

- Cracks, spalls, and separations noted in the downstream wing walls during the previous inspection appeared to be in about the same condition.
- The fish ladder structure exhibited cracks and spalls along with sediment buildup and vegetation.
- Weep holes along the base of the left spillway sidewall showed some evidence of flow. Weep holes along the right sidewall appeared to be dry (no flow). This condition matched what was noted in the last inspection.
- Concrete slope protection at the left end of the spillway retaining wall was noted in the last inspection to have some seepage and undermining occurring. No undermining was noted during this inspection. However, seepage was evident in this approximate area (near the identified seepage area on the downstream slope).
- Areas of scour noted in the last inspection along the downstream channel banks (based on a 2011 LiDAR assessment) were not visually observed during this inspection due to the water level.

EMERGENCY SPILLWAY

- The emergency spillway is a 230-ft wide low area in the middle of the embankment just north of the service spillway, but south of the diversion canal. The spillway was previously identified in owner provided data as being 303-ft wide. However, based on aerial/GIS information, a 230-ft wide spillway appears more accurate.
- However, as also noted with the crest, 2011 LiDAR data provides evidence that the spillway's control section may be only 150-ft long and 1.6-ft higher than TCEQ's records. When considering this difference along with apparent low areas along the dam crest, there may be less than 2-ft difference between the emergency spillway and the effective top of dam elevation (TCEQ records reflect a 5-ft difference).
- The spillway had a good grass surface with few obstructions and was found in good overall condition (See Photos 21-23).
- Rock rip rap (appeared to be stockpiled and not purposely placed for erosion protection) was noted just downstream of the emergency spillway crest.
- No significant erosion or burrows were noted.

HEADGATE AND DIVERSION CANAL

- The diversion canal and headgate structure consists of an approximate 50-ft wide earthen channel which diverts water from the river just upstream of the main channel dam through a canal to the powerhouse and turbine generators located 1.7 miles downstream. The gate system consists of a concrete structure and 2 steel radial tainter gates behind concrete headwall gates. All of the gates are maintained in an open position to allow flow through the canal and on to the generating station. The canal and gate system was found in good overall condition (See Photos 24-29).
- Rust on the tainter gate trunions was noted in the previous inspection but was not observed during this inspection as the trunions were submerged.
- Some grass along the channel sidewalls was noted growing through parts of the concrete sidewalls.
- GBRA staff noted that the canal has some leakage problems and that as part of their maintenance program they allow the canal to drain down and repair the channel as necessary.
- An earthen spillway in the diversion canal was installed (approximately 900-ft downstream of the headgate) since the last inspection. This spillway allows overflow in the canal to be directed (southwest) back towards the main channel of the river to prevent a possible breach of the canal. The spillway was found to be in good condition.

POWERHOUSE AND TURBINE

- The powerhouse and turbine generators were not assessed on operational conditions. However, GBRA did not report any operating deficiencies with the overall system. The concrete inlet and outlet structures were examined and found to be in good overall condition (See Photos 30-33).
- Small trees and shrubs were noted to be growing around the downstream end of the debris chute.

GATE OPERATIONS PLAN

A gate operations plan was submitted to TCEQ Dam Safety in December 2010.

DOWNSTREAM CHANNEL

The dam is an in-channel structure directly on the Guadalupe River. The river banks narrow considerable in the area immediately downstream of the spillway before widening back out to the same width as upstream of the dam at about the location of the canal and main channel confluence (1.7 miles downstream).

CONFIDENTIAL

DOWNSTREAM HAZARDS

This dam is currently classified as a high hazard dam (as also confirmed by the 2010 draft breach analysis conducted by owner's engineer). A breach of the dam would adversely affect (overtop) both Lake McQueeney and Lake Placid Dams, 7.6 and 12.9 miles downstream respectively. A breach of the dam would also adversely affect multiple residential structures (primarily lake homes along McQueeney Lake) and FM78 and SH123 (both classified by TXDOT as arterial roadways). Additionally, the loss of the dam could affect the hydropower production capacity which would be considered an economic loss to the region. Therefore, the hazard rating of high is appropriate for this dam.

HYDROLOGIC / HYDRAULIC ANALYSES

A dam of this size (Intermediate) and hazard classification, per 30 Texas Administrative Code §299.15, should be able to safely pass 75% of the Probable Maximum Flood (PMF). TCEQ Dam Safety records indicate that a draft Hydrologic and Hydraulic analysis (H&H) for the dam was conducted in December 2010 by Freese and Nichols, Inc. which showed the dam capable of passing only 36.5% of the PMF. Therefore, the dam is considered hydraulically inadequate. As a final note to the draft H&H analysis, 2011 LiDAR and GIS data suggest that the effective top of the dam may be lower and the emergency spillway higher and not as wide as modelled.

OPERATION AND MAINTENANCE (O&M) PLAN

The dam is in good condition and it is clear that maintenance is being performed. An Operations and Maintenance Plan is on file with TCEQ Dam Safety.

EMERGENCY ACTION PLAN (EAP)

A draft Emergency Action Plan (EAP) for this dam was submitted to TCEQ Dam Safety on December 29, 2010, and comments were provided on November 17, 2011. A finalized revision with signatures is required to complete the EAP.

POST INSEPCTION

GBRA reported that on the morning of May 14, 2019, one of the gates was damaged and failed during high flows.

REQUIREMENTS/RECOMMENDATIONS

The following requirements and/or recommendations are provided:

1. A finalized EAP draft should be submitted to the TCEQ Dam Safety Program. Upon submittal of the draft version in 2010 by the owner's engineer, comments to the draft EAP as well as the draft H&H and Breach Analysis were provided in November of 2011. In addition to the comments provided at that time, the finalized EAP, H&H, and Breach Analysis should be revised as necessary to account for potential/apparent elevation discrepancies (based on LiDAR data) noted in this report.
2. The dam is currently considered hydraulically inadequate. In consultation with the owner's engineer, a long-range plan should be developed to determine the most cost-effective measures to address the current hydraulic inadequacy of the dam. Any proposed plans need to be submitted to TCEQ Dam Safety for review and approval prior to beginning construction.
3. LiDAR data (from 2011) identified low areas along the crest as well as differences (higher elevation of the emergency spillway) from what is currently noted in the Texas Inventory of dams. It is recommended that a level survey be conducted to identify on the ground elevations as well as to provide accurate information in conjunction with any future H&H analysis. Lastly, until a comprehensive plan is in place to address hydraulic adequacy, it is recommended that the results of the survey be applied to level the top of dam and reduce the high areas of the emergency spillway.
4. Cracks, undermining, and spalls primarily on the left side spillway retaining walls and nearby slope protection need to be repaired/grouted as necessary (in some cases re-grouted when

they become exposed) and monitored for movement and changes to overall condition.

5. Scour and spalled areas identified by previous underwater inspections should be incorporated into a long-range plan for repairs. Any proposed plans need to be submitted to TCEQ Dam Safety for review and approval prior to beginning construction.
6. Scour along the downstream banks (immediately beyond the end of the spillway retaining walls and typically below the waterline) should be addressed with an assessment of the current erosion and a long-range plan to mitigate any on-going erosion from future flood events.
7. The following are recommendations for addressing the maintenance items noted during the inspection:
   a) In consultation with a Texas Licensed Professional Engineer (TLPE) with dam safety experience identify a long-range solution for the layer of seepage along the left downstream side of the groin area near the service spillway. Any proposed plans need to be submitted to TCEQ Dam Safety for review and approval prior to beginning construction.
   b) Seepage has also been noted on the right side of the spillway near the downstream wingwall. This should also be investigated to determine if a seepage layer exists at the same level as noted on the left side.
   c) Continue the maintenance program of sealing all open joints and cracks, and patching spalls and exposed rebar in concrete throughout all components of the structure.
   d) Cracks and spalls primarily on the left side spillway should be monitored for movement and overall changes to condition as part of the regular maintenance program. This will help to identify if there are larger concerns with global movement of retaining walls or potential structural concerns from internal seepage. As previously recommended in the 2013 TCEQ inspection report, several monitoring devices/monuments should be included in your monitoring plan (7 distinct areas were identified in the 2013 report).
   e) Remove unwanted vegetation growing on the timbers of the spillway gates and along walls, weep holes, and structure of the spillway, as well as sediment buildup and vegetation in fish ladder.
   f) Animal burrow holes, although not noted during this inspection, should be filled and compacted with appropriate fill material when found.

g) Remove all trees and unwanted vegetation from behind concrete walls, and slope protection around the canal headgate and powerhouse and turbine structures.

CONCLUSION

The owner of this dam may be liable for downstream damages in the event of a spill or breach. It is the owner's responsibility to maintain the dam in a safe condition in order to prevent loss of life and limit the potential for property loss. In addition, regular maintenance may reduce future rehabilitation and repair costs. This structure will be scheduled for re-inspection in 5 years, or in conjunction with any modifications.

Robert Calderon, P.E.
Dam Safety Section
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Michelle Lu, EIT
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Figure 1 – Location Map – Lake Dunlap Dam

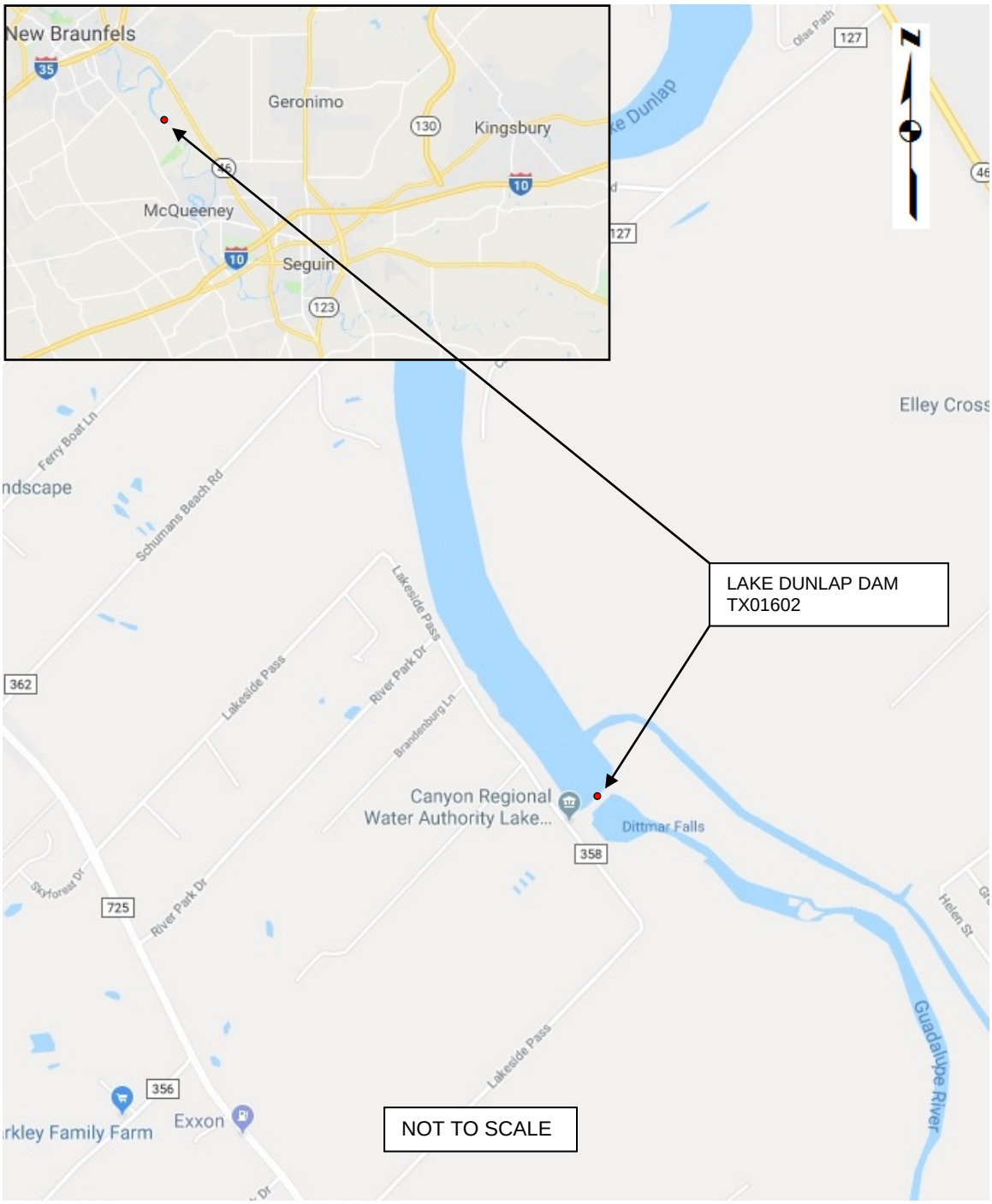

Figure 2–Aerial View (2016)
Lake Dunlap Dam - 10' Contours

Figure 3 – Lake Dunlap Dam
Sketch and Photo Locations

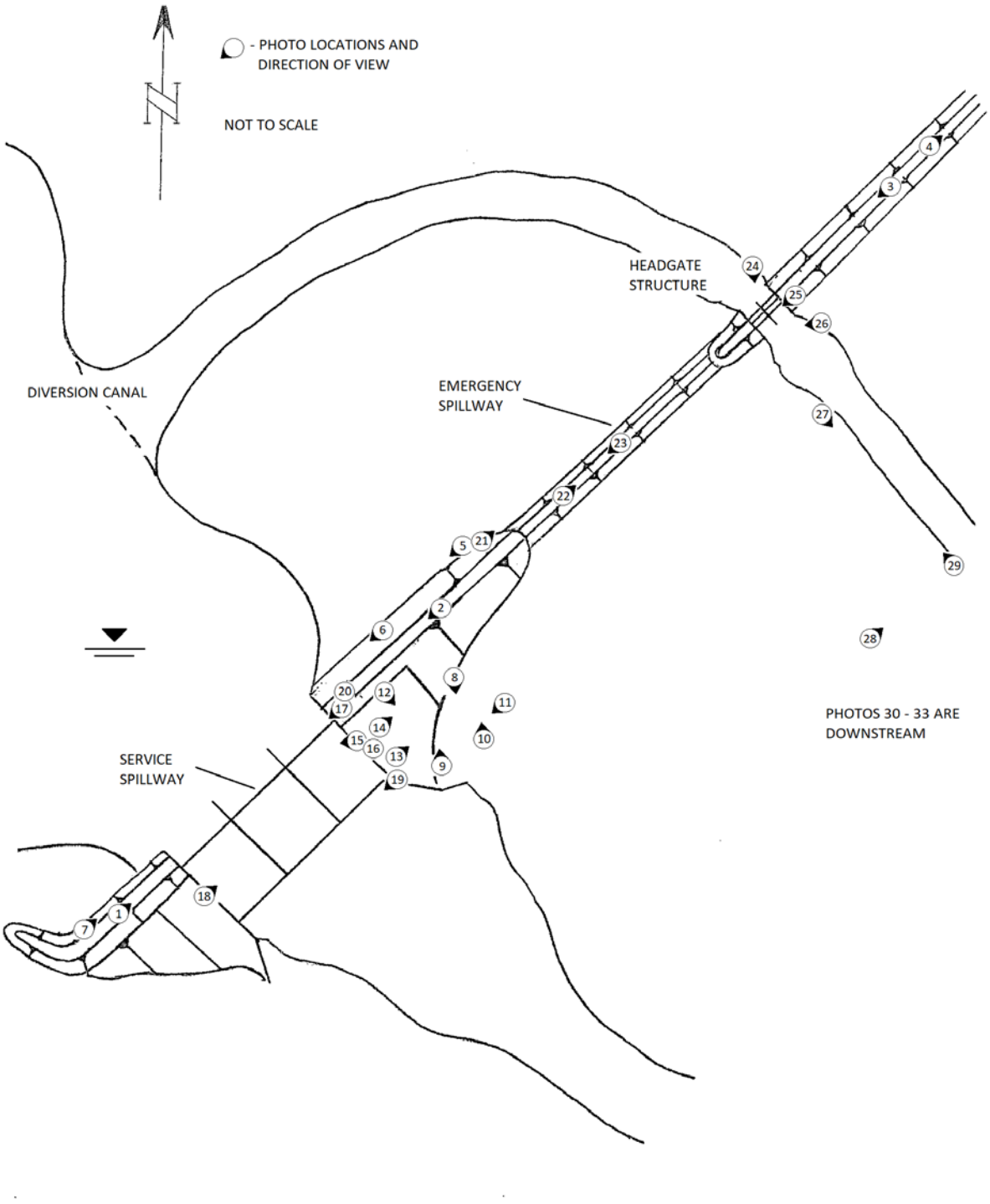

Photo #1 – Crest of dam from south side of river looking northeast (Approx. 8-ft wide). Note the slight crown and good grass cover.

Photo #2 – Crest of dam from north side of the river looking southwest (Approx. 8-ft wide).

Photo #3 – Crest of dam north of the diversion canal looking southwest. Note the crest appears to be slightly uneven along this section.

Photo #4 – Crest of dam north of the diversion canal looking northeast.

Photo #5 – View of dam's upstream slope north of the river looking southwest. Note all of the concrete slope protection is patched and sealed at all of the joints and cracks.

Photo #6 – View of dam's upstream slope north of the river looking southwest. No open joints or cracks were left unpatched.

Photo #7 – View of dam's upstream slope south of the river looking northeast. The walls and slope protection are in good condition. However, some exposed rebar was noted in the concrete wall (arrow).

Photo #8 – View of dam's downstream slope north of the river looking south. Note the slope in this area has been graded to expose a seepage layer. GBRA staff were in the process of determining the full extents of the seepage and working with their engineer to develop a long-term solution.

Photo #9 – View of dam's downstream slope north of the river looking north (at location of seepage layer).

Photo #10 – Close up view of seepage passing beneath the temporary weir.

Photo #11 – Close up view of seepage layer looking southwest.

Photo #12 – View of dam's downstream slope north of the river looking southeast. The concrete apron is worn but has been sealed and patched.

Photo #13 – View of dam's downstream slope north of the river looking northeast. The concrete apron is worn but has been sealed and patched and is functional.

Photo #14 – View of dam's downstream slope north of the river looking northeast. A layer of soil cement was placed above the concrete apron to help stabilize the slope.

Photo #15 – View of the service spillway and gates looking west.

Photo #16 – View of the service spillway and gates looking west. Note vegetation growing through timber near the bottom of the gate.

Photo #17 – View of the service spillway and gates looking southwest.

Photo #18 – View of the service spillway and gates from south of the river looking northeast. Note debris and sediment (arrow) that has built up around the base of the splash pad and fish ladder structure.

Photo #19 – View of the splash pad at the base of the spillway looking southwest. The concrete pad has some sediment buildup and vegetation.

Photo #20 – View of the manual elevation gauge from inside the control building.

Photo #21 – View of the emergency spillway from just north of the river looking northeast. Note the concrete structures indicate the control point of the spillway from the embankment sections of the dam. Flow would be from left to right (arrow).

Photo #22 – View from the control point of the emergency spillway looking northeast (diversion canal is in background). Note the good grass cover with no erosion or obstructions. Flow would be from left to right if the spillway engaged.

Photo #23 – View from the control point of the emergency spillway looking southwest.

Photo #24 – View of the diversion canal and headgate looking south (from upstream to downstream).

Photo #25 – View of the diversion canal and open radial tainter gates looking southwest. Note some grass growing through the sidewall.

Photo #26 – Close up view of the tainter gates looking west. The gates trunions were submerged and could not be observed. The gates remained in the open position.

Photo #27 – View of the diversion canal just downstream of the gates looking southeast.

Photo #28 – Panoramic view of the diversion canal spillway looking northeast.

Photo #29 – View of the diversion canal at the overflow spillway entrance looking northwest towards the headgate structure (upstream). Canal spillway flows from right to left (arrow).

Photo #30 – View of the inlet and bypass (debris chute) to the powerhouse at the downstream end of the diversion canal looking southwest.

Photo #31 – Close up view of debris screen and inlet to the powerhouse looking southeast.

Photo #32 – View from top of the concrete debris chute at the powerhouse looking southwest into main channel of the river. Note the overgrowth of trees and shrubs around the concrete sidewalls.

Photo #33 – View of the powerhouse building looking southwest. Main channel of the river can be seen below.